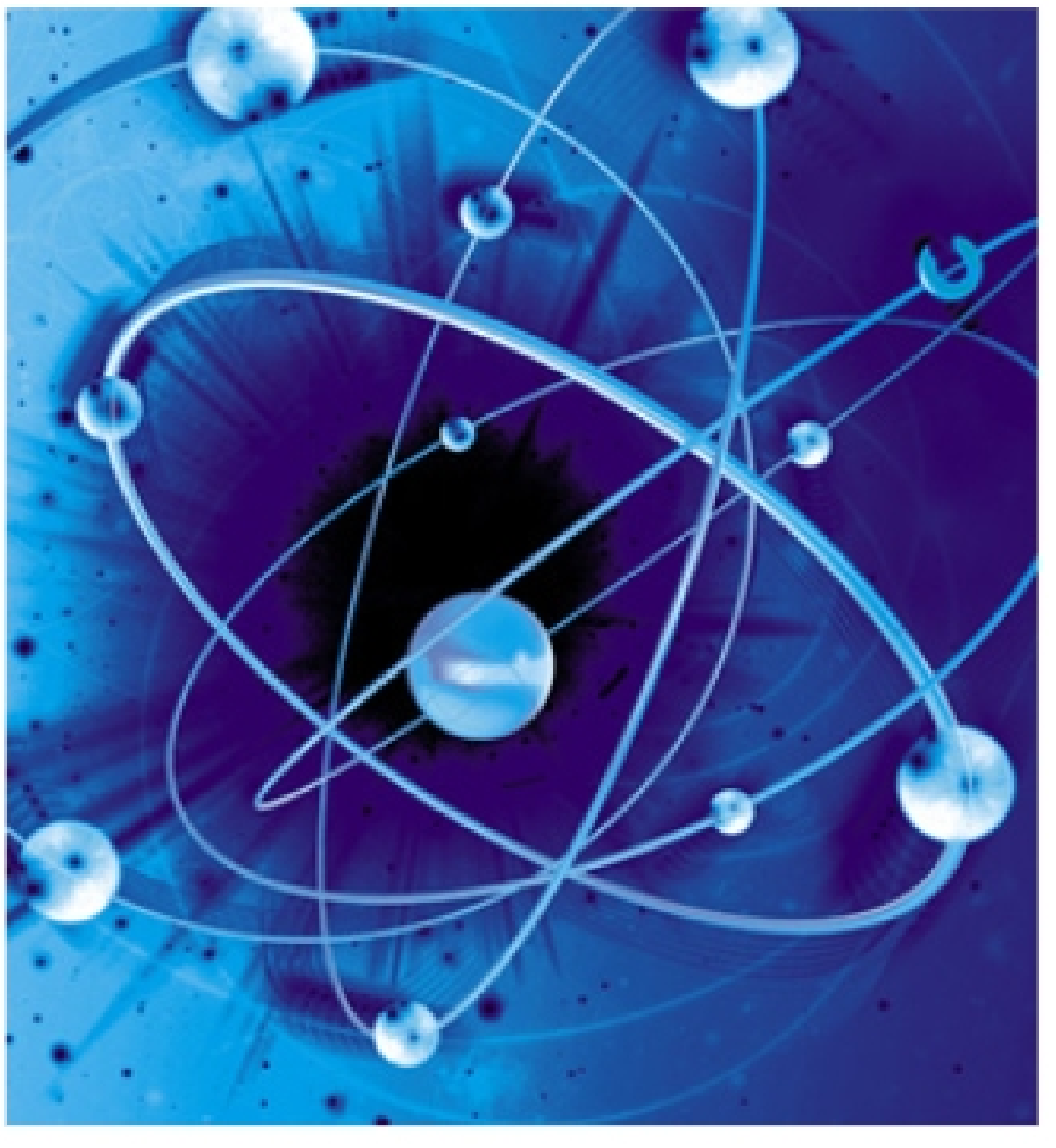
CHEM 101

Atoms, Molecules, and Ions



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Chapter 2

A Bit of History: The Atomic Theory of Matter

Atomos - Democritus (460-370$_{BCE}$) and others described the material world as made up of tiny indivisible particles (atomos or atoms) meaning "indivisible" or "uncuttable".

Atoms are the fundamental building blocks of matter reemerged in the early 19th century by John Dalton

John Dalton - theory explains several laws of chemical combination.

- **Law of constant composition** (based on postulate 4)

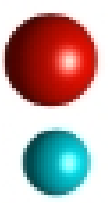
- **Law of Conservation of Mass** (based on postulate 5): The total mass of materials present after a chemical reaction is the same as the total mass present before the reaction.

reactants (same mass) ⟶ products (same mass)

- **Law of Multiple Proportions**: If two elements A and B combine to form more than one compound, them masses of B that combine with given mass of A are in the ratio of small whole numbers.

Dalton's Atomic Theory

1. Each element is composed of extremely small particles called atoms.



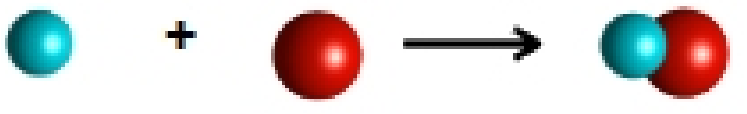
- an atom of the element oxygen (O)

- an atom of the element nitrogen (N)

2. All atoms of a given element are identical, but the atoms of one element are different from the atoms of all other elements.

3. Atoms of one element cannot be changed into atoms of a different element by chemical reactions; **atoms are neither created not destroyed in chemical reactions.**

4. Compounds are formed when atoms of more than one element combine; a given compound alway has the same relative number and kind of atoms.



Chapter 2

*This will be used to replace the word electron(s)

The Discovery of Atomic Structure

Cathode Rays and Electrons(e-)*

When a high voltage was applied to electrodes in a glass tube pumped almost empty with air, radiation was produced between the electrodes.

This radiation is called cathode rays. These rays originated at the negative electrode and traveled to the positive electrode.

J.J Thompson (1845-1940) - A British scientist whom observed that cathode rays are the same regardless of the identity of the cathode material.

- Thompson described cathode rays a streams of negatively charged particles.This was later known as the discovery of the electron.

-Thompson found the mass of an (e-) by adjusting the strength of a magnet and electrically charged plates until they were balanced in a cathode ray he constructed himself.

- He calculated $1.76 * 10^8$ coulombs (C) per gram for the ratio of the (e-)'s electrical charge to its mass.

Robert Milikan conducted an oil-drop experiment to deduce the mass of an election initially using Thompson's charge-to mass ratio: $1.76 * 10^8$ C/g and his own experimental value for charge: $1.602 * 10^{-19}$

$$\text{Electron mass} = \frac{1.602 * 10^{-19}}{1.76 * 10^8} = 9.10 * 10^{-28}\ \text{g}$$

Radioactivity - spontaneous emission of high-energy radiation

Ernest Rutherford revealed three types of radiation:

alpha(α): 2+ beta(β): 1- gamma (γ):no charge

The paths of alpha(+) and beta(-) radiation are bent by an electric field (in opposite directions) Whereas gamma radiation is unaffected by the field.

The Nuclear Model of the Atom

Rutherford postulated a very small dense nucleus with the (e-)'s around the outside of the atom.

- Found after the gold-foil experiment (Most of the volume is empty space)